The influence of decision-making rules on individual preference for ecological restoration: Evidence from an experimental survey

Nobuyuki Ito [1], Kenji Takeuchi [1*], Koichi Kuriyama [2], Yasushi Shoji [3], Takahiro Tsuge [4], and Yohei Mitani [2]

1 Graduate School of Economics, Kobe University, Japan

2 School of Political Science and Economics, Waseda University, Japan

3 Graduate School of Agriculture, Hokkaido University, Japan

4 Faculty of Economics, Konan University, Japan

[*] Graduate School of Economics, Kobe University, Rokkodai 2-1, Kobe 657-8501, Japan;
E-mail: takeuchi@econ.kobe-u.ac.jp

Abstract

We conduct an experimental survey to analyze how rules for collective decision-making influence individual preferences concerning nature restoration projects. Our study compares two decision-making rules—a consensus rule and a majority rule—wherein participants decide on a plan concerning nature restoration in the Kushiro Wetland, Japan. Our main finding is that the difference between the individual preferences and collective decision-making is less significant under the consensus rule than the majority rule. Furthermore, there is a larger disparity with regard to the marginal willingness to pay between collective and individual decisions when participants are unsatisfied with the results of collective choice.

Keywords: Participatory approaches, Decision making rules, Stated preference, Environmental valuation, Ecological restoration

1. Introduction

Along with the development and refinement of stated preference techniques, many studies have pointed out the tension between individual preference and social decision-making in the context of environmental management (Blamey, 1996; Sagoff, 1998; Russel et al., 2003; Vatn, 2004). For example, Blamey (1996) suggests that the respondents in a contingent valuation survey should not be treated as consumers of environmental goods, but rather as citizens who think of the welfare of the community when responding to environmental issues. Sagoff (1998) also suggests that consumer preferences reflect conceptions of the good life that individuals seek for themselves, while citizen preferences reflect conceptions of the good society offered to others for their consideration and acceptance.

Corresponding to these notions are several studies incorporating the participatory and deliberative approach within stated preference methodology (Davis and Whittington, 1998; Kenyon et al., 2001, 2003; MacMillan et al, 2002; Urama and Hodge, 2006). Examples of recent studies involve the stated preference survey in combination with the citizen's jury (Álvarez-Farizo and Hanley, 2006; Álvarez-Farizo et al. 2007)

and theoretical analysis of the aggregation of values in a deliberative group decision (Howarth and Wilson, 2006). While these studies suggest the significant role of the participatory approach, there has not been an empirical and quantitative study that systematically compares different decision-making rules employed in the participatory process with respect to its influence on individual preferences. A representative decision-making rule is a consensus rule, according to which, a proposal is discussed until there are no obvious objections. While this may be useful in being able to convince the public who participate in the process, its relative performance with respect to other decision-making rules is indeterminable in the absence of a quantitative analysis. Since there are a variety of ways in which individuals reveal their collective views, a comparison would be useful in order to assess the validity of the participatory approach.

This study uses an experimental survey involving a stated choice (SC) questionnaire to investigate how decision-making rules applied in discussion-based meetings can have an impact on the result of collective choice and individual preferences. Our study aims to compare two decision-making rules—the consensus rule and the majority rule—in a situation wherein members of a group discussion decide on the preferable plan for nature restoration. In order to study the significance of decision-making processes, we form groups comprised of members of the general public and asked them to arrive at a decision in the manner in which the actual committee members would decide on a nature restoration plan.

2. Preferences and decision-making rules

Since the seminal work by Arrow (1951), social choice theorists have shown that, generally, collectively rational decisions cannot be reached by democratic processes. On the other hand, the practical demand of an administrative agency for an operational decision-making tool drives the institutionalization of cost-benefit analysis and stated preference techniques in project appraisal and regulatory impact assessment. As noted earlier, the practice has been challenged by the philosophical consideration of the tension between the individualistic and collective point of view. This line of argument often leads to the claim for participatory or deliberative approach (Spash, 2008).

Deliberative decision-making can involve a variety of voting institution such as consensus rule or majority rule as a method of collective choice. A theoretical study conducted by Buchanan and Tullock (1962) argue that in the absence of “decision-making costs,” the unanimity rule is socially optimal. In contrast, Guttman (1998) shows that the unanimity rule is suboptimal and a simple majority rule is found to be socially optimal when efficiency and stability are used as the criteria for evaluation.

This study, using experimental settings, compares the consensus rule with the majority rule applied in the context of environmental decision-making. The purpose of the study is to empirically understand the relative performance of alternative rules in participatory processes. The stated preference technique is used as a tool for capturing the individual and group preference and investigating the disparity between them.

3. Survey

3.1. Background

Our case study uses an example of the nature restoration project in Kushiro wetland, Japan. The restoration project is based on the Law for the Promotion of Nature Restoration enforced in January 2003. The law requires the conductor of the nature restoration project to form a Nature Restoration Committee (NRC) with local governments, governmental agencies, and other parties, including local residents and nonprofit organizations, who intend to participate in the project. NRCs under the Nature Restoration Law can be regarded as an attempt to reflect the citizens' preferences regarding the public projects that can have various impacts on the environment.

The Kushiro wetland is well-known for being the largest wetland in Japan, although the area has been strained by the increment of sand flow into the central area, owing mainly to human activities for agricultural, industrial, and residential purposes. As of March 2008, five nature restoration projects will be conducted to prevent sand flow into the wetland. The Kushiro Wetland Nature Restoration Committee (KWNRC) has several subcommittees, which have held over fifty meetings since its establishment.

3.2. The experiment of collective decision-making

In September 2007, a market research company recruited candidates for participating in a study conducted among the people residing in Kushiro City. As a prerequisite, the participants were asked to respond to an SC survey from their homes and then bring along the responses on the day of the experiment. We refer to this take-home survey as "Questionnaire 0."

The experiment was held at a community center in Kushiro City, and the procedure comprised of the following three sessions. Thirty-six of the recruited candidates participated in our experiments.

In the first session of the experiment, the participants assembled in a room and learned about the nature of restoration projects in the Kushiro wetland. The moderator provided a brief summary of the experimental procedure. Throughout the experiment, the role of moderator is restricted to provide objective information and explain the procedure of the survey. The information that was provided on nature restoration in the first session was also included in Questionnaire 0. Therefore, the respondents could refer to the material as supplemental information throughout the experiment. After the presentation by the moderator, we allocated time to the participants for questions and answers. These procedures took less than twenty minutes. At the end of the session, the participants responded individually to Questionnaire 1 that contained the SC survey wherein they selected the most preferable nature restoration project plan from three alternatives.

In the second session, the participants were divided into six groups, each consisting of six people, and each group was moved to a separate room. Three of the six groups adopted the consensus rule, while the other three groups adopted the majority rule. The moderators assigned to each group explained to their respective groups what is entailed in the adoption of a decision-making rule and the procedure of group decision-making. Next, the participants were allowed to freely discuss the proposed nature restoration plan. The issues that were raised in the group discussion pertained to, for instance, the expression of doubts or agreement concerning each project, concerns regarding the cost of implementing the restoration plan, and the intention to preserve the natural state of environment for future generations. The discussion continued

for about twenty minutes. In the end of the second session, the participants responded individually to the SC survey, Questionnaire 2.

In the third session, collective decision-making was implemented. They responded to the SC survey collectively with the procedures of decision-making varied depending on the rule that was adopted by each group. In the groups that adopted the majority rule, the moderator proposed three alternative project plans sequentially, and the members of the group raised their hands when their favorite plan was suggested. In groups that adopted the consensus rule, the moderator selected a member by casting the dice, who proposed her most preferred plan. Next, the members of the group discussed among themselves until they arrived at a consensus on the plan that they considered to be the best. They could skip the consensus-building process in cases wherein they were unable to arrive at a consensus within three minutes, and retry it after a consensus was arrived at on all other issues.

The collective choice data was treated as though all group members chose the same alternatives in group decisions. At the same time, the data on the preferred alternatives of individuals was also tracked in both majority- and consensus-rule groups. At the end of the third session, the respondents participated in a survey that asked them to rate the degree of satisfaction they derived from the collective decision and provide general feedback on the experiment.

3.3. Design of the stated choice survey

Each questionnaire to which the participants responded individually contained the SC survey (Louviere et al 2000). We considered three projects as attributes in a choice set of the SC: (i) *the setting and managing of a sedimentation pond*, (ii) *restoration of the meandering stream from a straightened river*, and (iii) *restoring and maintaining forests.* These attributes have already been planned for implementation by the KWNRC, and it is expected that the present plan will achieve 24% of the projected reduction in sand flow.

The *sedimentation pond* is the project concerned with settling the sand contained in the agriculture drainage before the water flows into the river. The Kushiro River carries sand from the catchments to the central area of the wetland. *The Meandering stream project* has been implemented in order to store the sand in the area outside the wetland. *The forest restoration project* is expected to enhance the water retention capacity of the forests.

The attributes in the profile contain a status-quo level that will be attained through the present plan, and we assumed that all the level of attributes in this plan is uniformly 8%, for purposes of simplification. The total amount of the reduction in sand flow that the present plan in the alternatives will achieve equals 24%. Table 1 demonstrates the attributes and levels used in the SC survey. The numbers in the table indicate a ratio of the quantity of the sand that is prevented from reaching the central area to the total sand inflow to the area. In order to infer the willingness to pay by the participants, an additional tax required to implement a hypothetical plan for restoration is included as the fourth attribute. The tax is assumed to be levied annually for ten years.

Table 1–Wetland restoration attributes and levels used in the SC

We developed 125 choice sets by using an orthogonal array method. An example of a choice set used in the questionnaires has been shown in Table 2.

Table 2–An example of choice set

Respondents chose the most preferred plan from among three alternatives. Plan 1 and Plan 2 are hypothetical projects that require that an additional tax be paid. The present plan implies a status-quo; thus, the additional tax is zero, and therefore, no additional project will be conducted.

The choices of the respondents between each alternative are analyzed using a conditional logit model. We assume an indirect utility function $U_{nj} = V_{nj} + \varepsilon_{nj}$, where V_{nj} is the observable utility when individual n chooses alternative j, and where ε_{nj} is the stochastic component of utility. A linear model is assumed for V_{nj} as equation (1). Here, *POND*, *RIVER*, and *FOREST* indicate the percentage of sand flow prevented by each project and ASC_i is an alternative specific constant reflecting the effect of choosing a virtual plan regardless of the attributes. *COST* is the amount of additional tax payment. Assuming that the random component of utility is distributed as type-I extreme value distribution, the probability of an alternative that individual n chooses can be expressed as equation (2).

$$V_{ni} = ASC_i + \beta_1 POND_i + \beta_2 RIVER_i + \beta_3 FOREST_i + \beta_4 COST_i . \quad (1)$$

$$P_{ni}(U_{ni} > U_{nj}, \forall i \neq j) = \frac{\exp\{\lambda V_{ni}\}}{\sum_j \exp\{\lambda V_{nj}\}} . \quad (2)$$

4. Results

The general estimation results of each group are presented in Tables 3 and 4. Most of the coefficients of attributes are significant across the questionnaires for both groups. In order to examine the impact of the presentation in session 1 and the discussions in session 2 on individual preferences, we compared the estimated parameter by testing the null hypothesis: $\beta_{Questionnaire0} = \beta_{Qusestionnaire1}$, $\beta_{Questionnaire1} = \beta_{Qusestionnaire2}$, and $\beta_{Questionnaire0} = \beta_{Qusestionnaire2}$. The test statistic is the log-likelihood ratio,

$$\mathrm{LR}_{i,r} = -2\ [\ln L(\beta_{restricted}) - \ln L(\beta_i)] \quad (3)$$

which is asymptotically distributed as a chi-squared random variable with four degrees of freedom. The test statistic has a critical value of 9.49 at the 5% confidence level. Therefore, when the value of $\mathrm{LR}_{i,j}$ exceeds 9.49, it implies that the preferences are different between Questionnaire *i* and Questionnaire *j* (Table 5).

Comparing the preference before and after the first session by testing $\mathrm{LR}_{1,0}$ with the null hypothesis: $\beta_{Qusestionnaire1} = \beta_{Questionnaire0}$, the effect of the moderator's presentation and question-and-answer session are

significant for both the groups. On the other hand, group discussion in the second session does not affect the preference for both groups.

Furthermore, with the null hypothesis: $\beta_{Qusestionnaire2} = \beta_{Collecitive\ Choice}$ in both groups, a comparison of the $LR_{C,2}$ between the majority-rule group and consensus-rule group shows that the significance of the difference between individual and collective decision-making is lower under the consensus than the majority rule.

Table 3–Estimation result of the majority-rule group

Table 4–Estimation result of the consensus-rule group

$LR_{C,1}$ and $LR_{C,2}$ show the difference between individual preferences in each questionnaire and the preference in collective decision. When $LR_{C,1}$ is compared to $LR_{C,2}$, it is found that $LR_{C,2}$ is smaller, regardless of the decision-making rules. As all the members were required to choose only one alternative in each group decision, the result indicates that the group discussion conducted among the groups reduced the diversity of the individual preferences and facilitated collective decision-making.

Table 5–Test of the log-likelihood ratio

5. Satisfaction with collective choice

To analyze the disparity in preferences between individual and group decision-making, we hypothesized that a group member will have two utility functions—individual and collective. If their individual preference is different from that of the group's, he/she may feel dissatisfied. The level of satisfaction can be measured by the answers to the question "Were you satisfied with the results of group decision?" at four levels in the last survey at the end of the third session. None of the members stated that they had been quite unsatisfied with the result of the group decision.

We investigate how a respondent feels when the group decision is different from their favorite alternative. We created two dummy variables (*UNSATISFIED* and *NQSATISFIED*) that indicated the respondents' degree of satisfaction with the collective choice situation. If a group member chooses an alternative different from that of the group decision and is not satisfied with the result; $UNSATISFIED_i$ takes the value one, and zero otherwise. If a group member chooses an alternative different from that of the group decision and is not quite satisfied (sufficiently satisfied) with the result, $NQSATISFIED_i$ takes the value one, and zero otherwise. The numbers of choice sets that conclude a collective decision conflicting with individual preferences are 34 out of 324 in the majority-rule groups and 27 out of 318 in the consensus-rule groups. Among these choice sets, the variable *UNSATISFIED* that takes the value of one for six times in the

majority-rule groups and four times in the consensus rule-groups, and the number of the variable *NQSATISFIED* takes one for 14 times in the majority-rule groups and 17 times in the consensus-rule groups.

$$V_{ni} = ASC_i + \beta_1 POND_i + \beta_2 RIVER + \beta_3 FOREST_i + \left(\beta_4 + \gamma_1 UNSATIFIED_i + \gamma_2 NQSATISFIED_i\right) COST_i \quad (4)$$

We pooled data on group decisions and individual decisions. A group decision is composed of six group members that are assumed to be voting for the same plan. On the other hand, data on individual decisions is the group members' decision that they individually choose as most preferable.

Table 6 presents the results of the estimation. There exists one major difference between the two decision-making rules. In the consensus rule, any individual can express her opinion when she wishes to oppose a proposal that may be approved by group decision-making. However, this does not apply to the majority rule. The *UNSATISFIED* and *NQSATISFIED* variables are not significant in groups that adopted the consensus rule, while both the variables are positive and significant in groups that adopted the majority rule. These results suggest that individuals who experienced unsatisfied results had higher individual marginal willingness to pay (MWTP) than others in the consensus groups, but this does not apply to those who involved in the majority groups.

Table 6–Estimation results of group decision-making

We compare the disparity in the MWTP of the individual decision to that of the group decision for the groups that adopted the majority rule. An individual who was dissatisfied with the group decision had a 216.5% disparity in MWTP between the individual decision and the group decision, while an individual who was not quite satisfied with the group decision had a 166.0% disparity. Thus, the disparity in MWTP in the group and individual decision is larger for the member who feels less satisfied with the collective choice. This suggest that those who are less satisfied are willing to pay more than group decisions and that the group decision making in this survey have a tendency to choose a modest alternative from the choice set.

$$\frac{MWTP_{UNSATISFIED}}{MWTP} = \left(-\frac{\beta_i}{\beta_4 + \gamma_1}\right) \Big/ \left(-\frac{\beta_i}{\beta_4}\right) = 216.5\%$$
$$\frac{MWTP_{NQSATISFIED}}{MWTP} = \left(-\frac{\beta_i}{\beta_4 + \gamma_2}\right) \Big/ \left(-\frac{\beta_i}{\beta_4}\right) = 166.0\% \quad (5)$$

6. Conclusion and remarks

Our main findings can be summarized as follows. First, the difference between the individual preferences

and collective decision-making is less significant under the consensus rule than the majority rule. Second, the degree of satisfaction that the member feels with the collective choice relates to individual MWTP in the majority-rule group but not in the consensus-rule group. Thirdly, in the majority-rule group, the greater the disparity in MWTP in the group and individual decision, the more dissatisfied the member feel.

With respect to the first point, the consensus rule is effective to provide such opportunity to the individuals participating to the project for the restoration of the natural environment. The participant expressed his/her opinion until he/she was satisfied with the collective decision in the consensus-rule groups. However, the members of the majority groups could not express their opinions. Consequently, the consensus rule might increase the potentiality to reflect the individual preference in the collective decision-makings.

Similar to the findings of Alvarez-Farizo and Hanley (2006), we also confirmed the change from individual preferences to collective preferences. Preferences changed significantly when people were given more information and the time to think or discuss when individuals participated in the main survey. However, in the majority-rule group, there is a larger disparity in the MWTP between individual and group decision when the dissatisfaction among the participants is higher. Although permitting the members to have discussions with each other reduces the diversity of individual preferences, it is difficult to convince the participants of a collective decision when there are great disparities of MWTP between the individual and collective decision.

Our result highlights the usefulness of a stated preference survey to investigate the function of different decision-making mechanisms adopted in deliberative decision makings. Further research is required to understand how a broader range of decision-making rules apply to various situations. Using the term "values jury," Brown et al. (1995) suggest that it is an important question as to what decision-making rules work better with different jury tasks and different numbers of jurors and as to what is the stability of jury judgments (e.g., how much do jurors vary across different juries). The quantitative assessment with stated preference survey will aid in such investigations.

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References

Álvarez-Farizo, B., Hanley, N., 2006. Improving the process of valuing non-market benefits: Combining citizens' juries with choice modeling, Land Economics 82 (3): 465–478.

Álvarez-Farizo, B., Hanley, N., Barberán, R., Lázaro, A., 2007. Choice modeling at the 'market stall': Individual versus collective interest in environmental valuation, Ecological Economics, 60: 743–751.

Arrow, K. J., 1951. Social Choice and Individual Values. New York, John Wiley and Sons.

Blamey, R. K., 1996. Citizens, consumers, and contingent valuation: clarification and the expression of

citizen values and issue-options, In: Adamowicz, W. L., Boxall, P. C., Luckert, M. K., Phillips W. E., White, W. A. (Editors), Forestry Economics and the Environment, Oxford University Press, pp. 103–133.

Brown, T. C., Peterson, G. L., Tonn, B. E., 1995. The values jury to aid natural resource decisions, Land Economics 71 (2): pp. 250–260.

Buchanan, J. M., Tullock, G., 1962. The calculus of consent. University of Michigan Press, Ann Arbor.

Davis, J. Whittington, D. 1998. "Participatory" research for development projects: A comparison of the community meeting and household survey techniques. Economic Development and Cultural Change 47 (Oct.): 73–94.

Guttman, J. M., 1998. Unanimity and majority rule: the calculus of consent reconsidered. European Journal of Political Economy, 14: 189–207.

Howarth, R. B., Wilson, M. A., 2006. A theoretical approach to deliberative valuation: aggregation by mutual consent, Land Economics 82 (1): 1–16.

Kenyon, W., Hanley, N. Nevin, C., 2001. Citizens' juries: an aid to environmental valuation? Environmental Planning C: Government and Policy 19 (4): 557–566.

Kenyon, W., Nevin, C., Hanley, N., 2003. Enhancing environmental decision-making using citizens' juries. Local Environment 8 (2): 221–232.

Louviere, J. J., Hensher, D. A., Swait, J. D., 2000. Stated choice methods: Analysis and application. Cambridge, U.K., Cambridge University Press.

Macmillan, D. C., Philip, L., Hanley, N., and Álvarez-Farizo, B., 2002. Valuing non-market benefit of wild goose conservation: a comparison of interview and group-based approaches, Ecological Economics 43: 49–59.

Russell, C. S., Bjorner, T. B., Clark, C. D., 2003. Searching for evidence for alternative preferences, public as opposed to private, Journal of Economic Behavior & Organization 51: 1–27.

Sagoff, M., 1998. Aggregation and deliberation in valuing environmental public goods: a look beyond contingent pricing, Ecological Economics 24: 213–230.

Spash, C. L., 2008. Deliberative monetary valuation and the evidence for a new value theory, Land Economics 84 (3): 469-488.

Urama, K. C., Hodge, I., 2006. Participatory environmental education and willingness to pay for river basin management: Empirical evidence from Nigeria, Land Economics 82 (4): 542-561.

Vatn, A., 2004. Environmental valuation and rationality, Land Economics 80 (1): 1–18.

Tables

Table 1 - Wetland restoration attributes and levels used in the SC					
Attribute	Level of each attribute				
Sedimentation Pond	8%	10%	12%	14%	16%
Meandering Stream	8%	10%	12%	14%	16%
Forest Restoration	8%	10%	12%	14%	16%
Additional Tax (Yen/year)	0	500	1000	2000	5000

Table 2 - An example of a choice set			
	Plan 1	Plan 2	Present plan
Sedimentation Pond	8%	14%	8%
Meandering Stream	14%	8%	8%
Forest Restoration	14%	14%	8%
Additional Tax (Yen/year)	1000	2000	0

Table 3 - Estimation results of the majority rule group									
Variable		Questionnaire 0		Questionnaire 1		Questionnaire 2		Collective Choice	
POND	Coefficient	–6.55E-02		–6.06E-02		–9.18E-02	*	–2.23E-01	***
	[St.Er.]	[5.30E-02]		[4.85E-02]		[5.09E-02]		[7.29E-02]	
RIVER	Coefficient	1.42E-01	**	1.04E-01	*	4.24E-02		7.65E-02	
	[St.Er.]	[5.96E-02]		[5.38E-02]		[5.34E-02]		[7.21E-02]	
FOREST	Coefficient	1.32E-01	**	8.79E-02		1.17E-01	**	3.13E-01	***
	[St.Er.]	[6.24E-02]		[5.37E-02]		[4.99E-02]		[7.88E-02]	
COST	Coefficient	–1.07E-03	***	–6.73E-04	***	–8.97E-04	***	–1.80E-03	***
	[St.Er.]	[1.64E-04]		[1.07E-04]		[1.36E-04]		[3.05E-04]	
ASC_1	Coefficient	1.943	***	1.597	***	2.087	***	2.133	***
	[St.Er.]	[5.21E-01]		[4.68E-01]		[4.71E-01]		[6.69E-01]	
ASC_2	Coefficient	1.915	***	1.367	***	1.714	***	2.307	***
	[St.Er.]	[5.24E-01]		[4.74E-01]		[4.82E-01]		[6.75E-01]	
Num. of obs.		162		162		162		162	
Log likelihood		–112.957		–133.187		–121.875		–80.825	
McFadden's R^2		0.365		0.252		0.315		0.546	

*** Significant at the 1% level; ** significant at the 5% level and * significant at the 10% level

Table 4 - Estimation result of the consensus rule group									
Variable		Questionnaire 0		Questionnaire 1		Questionnaire 2		Collective Choice	
POND	Coefficient	–1.73E-01	***	2.79E-02		5.87E-02		–3.30E-02	
	[St.Er.]	[5.13E-02]		[4.41E-02]		[4.83E-02]		[5.57E-02]	
RIVER	Coefficient	2.87E-02		5.21E-02		8.76E-02		2.25E-01	***
	[St.Er.]	[5.33E-02]		[4.84E-02]		[5.42E-02]		[7.24E-02]	
FOREST	Coefficient	1.38E-01	***	1.63E-01	***	1.67E-01	***	1.37E-01	**
	[St.Er.]	[4.94E-02]		[4.76E-02]		[5.30E-02]		[6.22E-02]	
COST	Coefficient	–5.42E-04	***	–5.41E-04	***	–6.98E-04	***	–9.06E-04	***
	[St.Er.]	[9.95E-05]		[9.71E-05]		[1.18E-04]		[1.46E-04]	
ASC_1	Coefficient	1.298	***	6.88E-01	***	4.30E-01		6.52E-01	
	[St.Er.]	[4.43E-01]		[4.07E-01]		[4.43E-01]		[5.46E-01]	
ASC_2	Coefficient	1.397	***	5.55E-01		1.58E-01		6.13E-01	
	[St.Er.]	[4.57E-01]		[4.17E-01]		[4.64E-01]		[5.74E-01]	
Num. of obs.		162		162		162		156	
Log likelihood		–140.047		–145.552		–140.111		–115.11	
McFadden's R^2		0.213		0.182		0.213		0.328	

*** Significant at the 1% level and ** significant at the 5% level

Table 5 - Test of the Log-likelihood ratio		
	Majority rule group	Consensus rule group
$LR_{1,0}$	11.69	22.66
$LR_{2,1}$	6.66	5.63
$LR_{2,0}$	7.72	29.45
$LR_{C,0}$	31.78	29.58
$LR_{C,1}$	53.03	18.86
$LR_{C,2}$	37.5	9.98

$LR_{i,r} = -2\ [\ln L(\beta_{restricted}) - \ln L(\beta_i)]$, where $\beta_{restricted}$ is the restricted parameter vector and β_i is the unrestricted parameter vector.

Table 6 Estimation result of group decision-making

	Majority rule group			Consensus rule group		
Variable	Coefficient		St.Er.	Coefficient		St.Er.
POND	–1.519E-01	***	4.619E-02	–3.328E-02		3.868E-02
RIVER	5.499E-02		4.607E-02	1.768E-01	***	5.026E-02
FOREST	2.808E-01	***	4.818E-02	1.576E-01	***	4.580E-02
COST	–1.366E-03	***	1.712E-04	–1.009E-03	***	1.149E-04
NQSATISFIED*COST	5.431E-04	**	2.750E-04	–6.620E-04		5.276E-04
UNSATISFIED*COST	7.351E-04	**	3.728E-04	4.444E-04		4.143E-04
ASC_1	1.429	***	4.109E-01	0.845	***	3.718E-01
ASC_2	1.548	***	4.116E-01	1.014	***	3.888E-01
Num of obs	324			318		
Log likelihood	–195.709			–235.3974		
McFadden's R^2	0.450			0.3262		

*** Significant at the 1% level, ** significant at the 5% level.